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HABITAT PREFERENCE AND UTILIZATION BY THE EASTERN CHIPMUNK (*TAMIAS STRIATUS*)

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Abstract

Chipmunks in study areas in southeastern Ohio occupy a wide range of vegetational situations, but highest densities and stable populations are found in forests that are in latter stages of succession and are characterized by mature trees, dense canopy, and sparse summer herbaceous vegetation. Sectors uninhabited by chipmunks are typified by dense growth of young trees and shrubs or sandy soil. Structural aspects of the soil and food availability affect burrow site selection and population structure. The role of dense ground cover as noise in the social communication channel is interpreted as a selective force in habitat selection.

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Introduction

The presence and abundance of a population in any given locality and the spatial distribution of individuals within that population are dependent upon the spatial and temporal allocation of the resources that are necessary for survival and reproduction of the individuals of the population. Some resources are limiting to a natural population in subtle ways, but other resources exert controls on populations in overt ways that can be quantified. The eastern chipmunk (*Tamias striatus*) occurs throughout the eastern United States and Canada in suitable habitat (Hall and Kelson 1959). Suitable habitat for this chipmunk includes a wide range of brushland and open forests (Forbes 1966). Population estimates of 1 to 39 individuals/ha are reported with 10 individuals/ha as an average density. The home range of the eastern chipmunk is usually less than 0.5 ha. The center of activity is a burrow system. The chipmunk hibernates from October to March. The burrow serves as a retreat from the elements, predators, and conspecifics, as well as a nursery and a hibernaculum. The availability of suitable sites for burrows thus constitutes a major resource upon which survival is determined and about which various factors can be measured.

The present study is concerned with the habitat utilization of the eastern chipmunk in southeastern Ohio, relating vegetational, topographic, and physiographic features to burrow sites and correlating these factors to chipmunk density and population structure.

Methods

The field study was conducted on three populations of chipmunks in Athens County, Ohio, during 1974. Population A inhabited a partially disturbed woodlot (Area I) approximately 5 ha in area, which is bordered on three sides by pasture and fields (Fig. 1). Three small streams traverse the woodlot. Population B occupied a wooded, rock-outcrop hillside (Area II) with a westerly exposure. Population C resided in a woodlot also containing a rock-outcrop, but the relief is less steep (Area III). Areas I and II were chosen because they contained a variety of vegetative, topographic, and physiographic features and varying degrees of man-made disturbances and uninhabited habitats. Area III was selected later as a comparison to Area II.

Chipmunks were live-trapped at known burrow systems with National live-traps. Individuals were sexed, categorized as to adult or juvenile, weighed, assessed as to reproductive condition, and marked with #1 ear tags (National

Band and Tag Co.) and fur dye (Nyanzol D) to facilitate field identification and burrow use.

Information about the age and sex of individuals occupying specific burrows, the slope in the immediate vicinity of the burrow entrance, the angle of exposure of the burrow site, and the proximity of the burrow entrance to solid objects was recorded on all burrows identified as occupied by specific individuals. Proximity to herbaceous and woody vegetation, the distance to man-induced disturbance at the burrow site, distance to water, position on a slope, amount of ground cover, drainage, and the number of burrow entrances within a 3-m radius of the main burrow entrance were also quantified for the most frequently utilized burrows at Areas I and II. Analysis of the vegetation at places with active burrows as well as at randomly selected points in unoccupied habitat was accomplished using 15-m transects at the 4 major points of the compass originating at a burrow site or a randomly selected point. Relative density, relative dominance, relative frequency, and importance values of woody and herbaceous species were calculated (Cox 1967). Percent canopy cover was estimated along line transects using the method of James and Shugart (1970).

Analysis of chipmunk densities and population structure were conducted from early June to September, after the dispersal of young of the spring litter. Population A was live-trapped continuously over this period, and all residents were identified. Population B was live-trapped over two, two-week intervals, and density was estimated by field observation of marked and unmarked animals.

Results

Area I can be divided into a sector high in chipmunk and burrow site densities and a sector in which chipmunks were not sighted and burrow sites were not found (Fig. 1). Area II also contained sectors in which chipmunks were either present or absent. Vegetative parameters were measured at 25 active burrow sites and 20 random points in unoccupied parts of the two areas. Two variables, total density of woody species and percent ground cover, are significantly different between the two areas (Table 1). There are no significant differences between inhabited and uninhabited sectors for values of relative dominance, relative density, relative frequency and importance values of individual herbaceous and woody species, absolute density and frequency of herbaceous species, or absolute frequency of woody species and canopy cover. Total dominance of woody species approaches significant at the 95% level.

The most dominant tree species in the occupied sector of Area I are *Quercus*

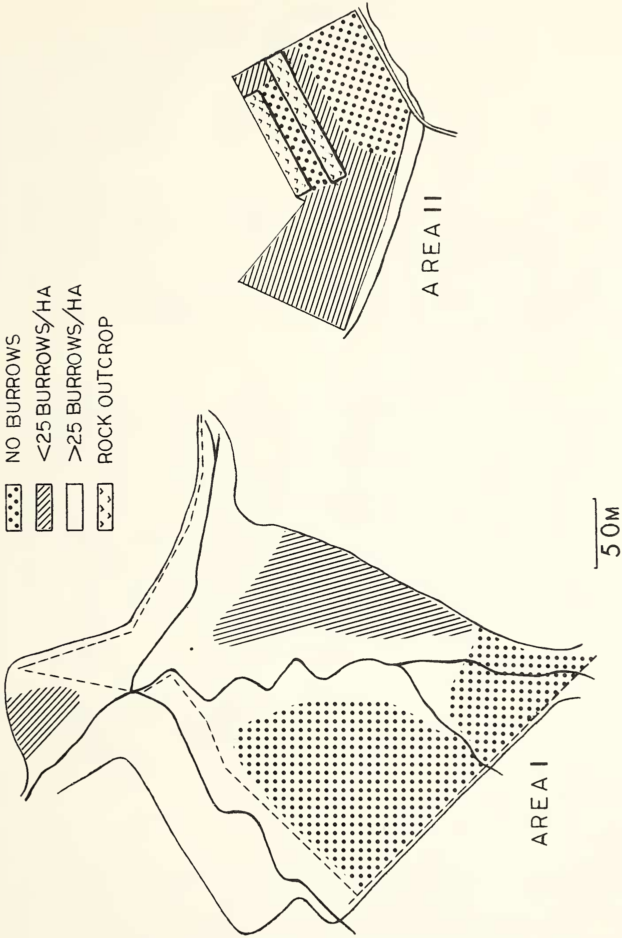

Fig. 1. Chipmunk study areas I and II in southeastern Ohio. Area I is bordered on all sides by cultivated fields or pasture. Area II is a hillside bordered to the west by a road and a stream and continuous with forest on the other sides.

TABLE 1
Vegetative Features of Chipmunk Habitation Areas

	AREA I		AREA II	
	Occupied section (n=21)	Unoccupied section (n=16)	Occupied section (n=4)	Unoccupied section (n=4)
Total density of woody plants/m²	1.83	3.24***	2.12	1.66
Ground cover as percent	22.21	32.73*	30.20	3.38***
Total dominance of woody species	8.95	6.46[1/]	4.66	3.20

(t-test; 1/=1.0>P>0.05, *=0.05, **=0.01, ***=0.001)

alba, *Q. prinus*, *Carya ovata*, *Acer saccharum*, *A. rubrum* and *Liriodendron tulipifera* and at Area II *Carya glabra*, *Betula lenta* and *Sassafras albidum*. In unoccupied sectors of Area I, *Fraxinus americana*, *Ulmus rubra* and *Gleditsia tricanthos* predominate, but at Area II only the shrubs *Viburnum ancerfolium*, *Vaccimium sp.* and *Kalmia latifolia* are common.

Measurements of the characteristics of 25 occupied burrow sites at Areas I and II were taken and analyzed using factor analysis (Rummel 1970). A factor analysis of the 25 variables yields 5 factors accounting for 67% of the total variance (Table 2). These factors are interpreted as follows. Factor I is concerned with variables relating to the position of a burrow on a slope and the vegetative features associated with that site. Canopy cover is less and density of herbs increases on greater slopes resulting in more ground cover, but leaf litter accumulation is less. The age of the animal inhabiting the burrow is correlated with slope. Factor II relates the herbaceous growth to burrow sites and indicates an association of burrows with larger trees. Factor III shows an association of slope to the sex of the occupant of the burrow and a relationship to the position of the burrow on that slope and age of the occupant. Factor IV clarifies the position of the burrow on the slope. Burrow systems on steep slopes are closer to the crest and have more burrow entrances. Factor V further clarifies the position of the burrow on a slope. A burrow located near the crest is most likely to be constructed beneath a solid object such as a stump, root, or large rock. This analysis provides an overview of habitat utilization by chipmunks and a test of specific hypotheses generated from the data. Burrow sites at all locations are in areas of good drainage. Soil composition is a sandy loam with high concentration of sand adjacent to sandstone outcrops.

TABLE 2
Factor Loading Scores of 25 Variables Measured at 25 Chipmunk Burrows in Areas I and II

	FACTORS				
	I[d]	II	III	IV	V
1. Slope	−0.39		−0.51	0.49	
2. Exposure					−0.75
3. Proximity to a solid object					−0.80
4. Distance to herbaceous vegetation			−0.25		
5. Distance to woody vegetation		0.67		0.30	−0.36
6. Sex of occupant			−0.84		
7. Distance to disturbed area	−0.33			−0.65	
8. Number of burrows				0.78	
9. Distance to crest of slope	−0.30		0.25	−0.39	0.61
10. Distance to bottom of slope			0.90		
11. Distance to water			0.95		
12. Age of occupant	−0.46		0.39		
13. Amount of leaf litter	0.66			−0.39	
14. Relative density of herbs		0.81			
15. Relative dominance of herbs		0.66			
16. Relative frequency of herbs		0.60		−0.39	−0.28
17. Importance value of herbs		0.76		−0.33	
18. Tree density	−0.54				
19. Tree basal area	−0.27	0.50			
20. % ground cover	−0.94				
21. % canopy cover	0.68				
22. Total tree density				0.36	
23. Total tree basal area					
24. Absolute density of herbs	−0.91				
25. Total importance value of herbs	−0.56	0.36		−0.36	
Total explained Variation	20%	19%	22%	8%	7%

([d]Zero factor loading is 0.2500 throughout)

Females occupy burrow sites on steeper slopes than do males, but no preference for slope can be found between age classes (Table 3). Twenty-three (26%) burrows were next to or beneath a solid object, 30 burrows (35%) were less than 1 m from a solid object but not beneath one, and 34 burrows (39%) were more than 1 m from a solid object. This distribution is not at variance with random ($X^2_{(2, 0.05)} < 2.33$).

TABLE 3

Relation of Chipmunk Burrow Sites to Slope, Sex of Occupant, and Age

	SEX		AGE CLASS	
	Male	Female	Adult	Juvenile
Number	50	37	63	24
Slope ($\overline{Y}$) in degrees	25	34*	29	31

(t-test; *=0.001)

The estimated density of chipmunks, taking into consideration the area of both occupied and unoccupied sections in Area I, was 11.8/ha for Population A and 4.5/ha for Population B. The ecological density was 19.6/ha and 7.5/ha, respectively. The population structure is given in Table 4. The ratio of adults to juveniles is 1:0.11 in Population A and 1:1.25 in Population B.

Discussion

The study areas contained sectors that chipmunks use extensively and other sectors that are not used (see Fig. 1). The presence of burrows characterizes the sectors used by chipmunks. The nonutilized sector of Area I differs from the occupied sector in percent ground cover and the high density of woody plants. At Area II, the unoccupied sector is located between and adjacent to rock-outcrops and is characterized by a sandy soil that supports negligible herbaceous growth and has a low percent ground cover (see Table 1). Stevenson (1962) found chipmunks in areas of heavy understory, and Forsythe and Smith (1973) reported high densities of chipmunks in the dense understory of edge habitats. The habitat of the latter study was characterized by a seasonally-abundant food resource that attracted chipmunks, but it was not determined in either study if the use of the dense understory fluctuated with temporal availability of the food resource and whether or not shifts in burrow systems occurred.

TABLE 4

Age Structure of Populations A and B in 1974

		Population A (n=59)	Population B (n=9)
ADULT	Male	26	3
	Female	27	1
JUVENILE	Male	4	5
	Female	2	0

Extensive lists of foods utilized by chipmunks are given by Howell (1929), Allen (1938), Richmond and Rosland (1949), Yerger (1955), and Siedel (1960). The wide variety of foods utilized by chipmunks indicates that they are able to exist in many types of habitats (Forbes 1966) and that factors other than food resources may be limiting. The occupied sector of Area I is characterized by a slightly higher total basal area (dominance) of woody species than is the unoccupied sector. The mature trees produce a plentiful mast crop and supply an ample food resource in autumn.

Gordon (1969) has described the natural vegetation in Ohio at the time of the arrival of the pioneers and records various accounts of the understory growth. A beech-sugar maple association was typical in southeastern Ohio. Summer herbaceous vegetation was scarce due to the dense shade of the canopy, but vernal and autumnal herbaceous plants were numerous and were those species that depend on animals for seed distribution. Chipmunks are adept seed gatherers, and they store caches of food in their burrows in the fall. The densely-shaded forest floor would also be favorable to growth of fungi, another potential food resource for the chipmunk. The mature forest provides for a food supply beginning in the late fall when the chipmunks become active and abundant and need ample food for weight gain and food caches. Subclimax and disturbed areas are represented by immature trees and shrubs; the latter provide a seasonally-abundant seed crop in autumn. The food resources are not as continuous as in the mature forest.

The optimal situation for chipmunk inhabitation may be hypothesized as a continuously available resource, and the highest densities and stable, reproducing populations of chipmunks would be found in these conditions. Areas of seasonally-abundant food sources attract transient adults and dispersing juveniles during seasonal abundance and are characterized by a fluctuating population density corresponding to availability of food resources (Yahner 1977, 1978a).

Chipmunks belong to the family Sciuridae, a group of primarily diurnal rodents that use visual signals extensively in communication with conspecifics (Svendsen 1973). These signals are necessary to maintain social organization. Dense undergrowth inhibits the flow of visual signals across the communication channel. It is likely that preference would be for areas with less understory growth in order to reduce noise in the channel. The occupied sectors of Area I and Area II have reduced understory growth with mature trees to provide a food supply, whereas the unoccupied sectors are characterized either by heavy herbaceous growth and dense stands of young trees or poor quality soil and poor herbaceous growth. A three-dimensional model relating chipmunk population density to vegetative features and soil conditions is given in Fig. 2. Disturbed areas, such as road banks, fence lines with cleared right-of-ways, and the

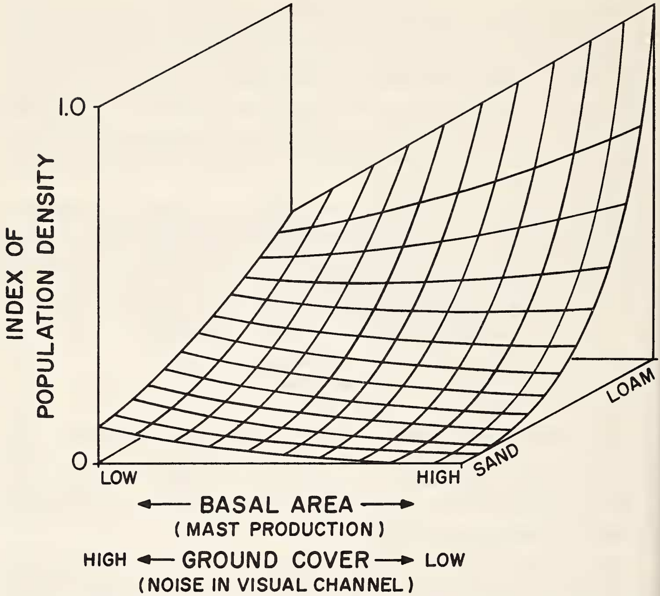

Fig. 2. A three-dimensional graph relating chipmunk population density to soil characteristics and vegetational features based on the data gathered from chipmunk populations in southeastern Ohio.

interface between forest and fields, were not utilized as permanent homesites. Chipmunks, however, would move into these areas in their travel.

Burrow systems of chipmunks have been reported to be located in well-drained soils (Seidel 1960), and we found chipmunk burrows in well-drained soils. The sandy soil along the outcrops at Area II provides excellent drainage, but no burrows were constructed there. High sand content possibly lacks the structural properties to support the tunnels. Chipmunks are known to use rock-outcrops as sites to construct burrows (Damon 1941; Manville 1949). Although no burrows are located in and along the outcrops at Area II, chipmunks did establish burrows at the outcrops of Area III. The soil at Area III is not sandy but a loam similar in texture to the occupied sector of Area I.

Chipmunk burrow systems have been observed beneath or near solid objects such as a fallen log, stump, or rock (Komarck 1932; Burt 1940; Barbour 1951;

Ernst and Ernst 1972; Thomas 1974), as well as in areas away from such structures (Metzgar 1955; Thomas 1974). Based on the 87 used burrows we studied, no relationship between the location of a burrow and the proximity of a solid object is evident. Rocks provide physical support of the burrow entrance of *Marmota flaviventris* in Colorado (Svendsen 1975) and are most important in preventing cave-ins during hibernation. These mountainous soils are formed by erosion and are coarse with little humus or clay content. The sandy soil in Area II is also formed from erosion of the rock-outcrops. *Marmota monax*, a common Ohio burrowing Sciuridae, does not restrict burrow sites to beneath solid objects. Approximately 50% of the burrows are constructed away from such support. Chipmunks may utilize solid objects to burrow beneath in areas in which soils are loose and cannot support burrows as in Area II in which sandy soil is found from erosion of rock-outcrops. This practice is abandoned, however, where soils are more structural in locations distant from the rock-outcrops in Area II.

Females occupy burrow sites on steeper slopes (Table 3) and position the burrow farther from the crest than do males. The preference by females for the steeper slopes within the general topography may be related to conditions of the burrow as a hibernaculum. Females shift burrow sites less during the year than do males (Burt 1940; but see Yahner 1978b) and have a greater tendency to remain in the hibernacula burrow system and raise the young. The data thus may reflect the optimal hibernacula sites, as represented by females, and demonstrate the vagility of the males. Other possible reasons for site selection on steeper slopes by females may be related to food resources and social organization. Hibernacula sites of males are presently being identified, and data relating social organization and food resources are being gathered to test these hypotheses.

The density of chipmunks on Area I is the highest of the study areas, and adults make up the established, burrow-occupying population (Table 4). Only six juveniles from the spring litter became established in the population on Area I, yet several litters were known to have been produced and were seen above ground (Yahner 1977, 1978a). It is presumed that most of the juveniles dispersed from the area and were not able to become established within the stable population already present. Population B is composed of juveniles that occupy a strip 10 to 30 m wide along the outcrop and of adults to the north and northwest of the outcrops. The only adult female on the area is in the latter sector. This female did not produce a litter during 1974. Ninety percent of the females in population A produced litters in 1974; several had two. The overall pattern appears to be a stable, reproducing, adult population in optimal forested areas, with disturbed areas and secondary growth forests serving as secondary habitat, utilized primarily by dispersing subadults and transient adults that have a reduced reproductive effort. The densities of the latter group in any given area respond to what seems to be a locally abundant and erratic food resource.

Acknowledgments

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